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A PICTORIAL GUIDE TO THE IDENTIFICATION OF IMPORTANT *FUSARIUM* SPECIES IN ALBERTA

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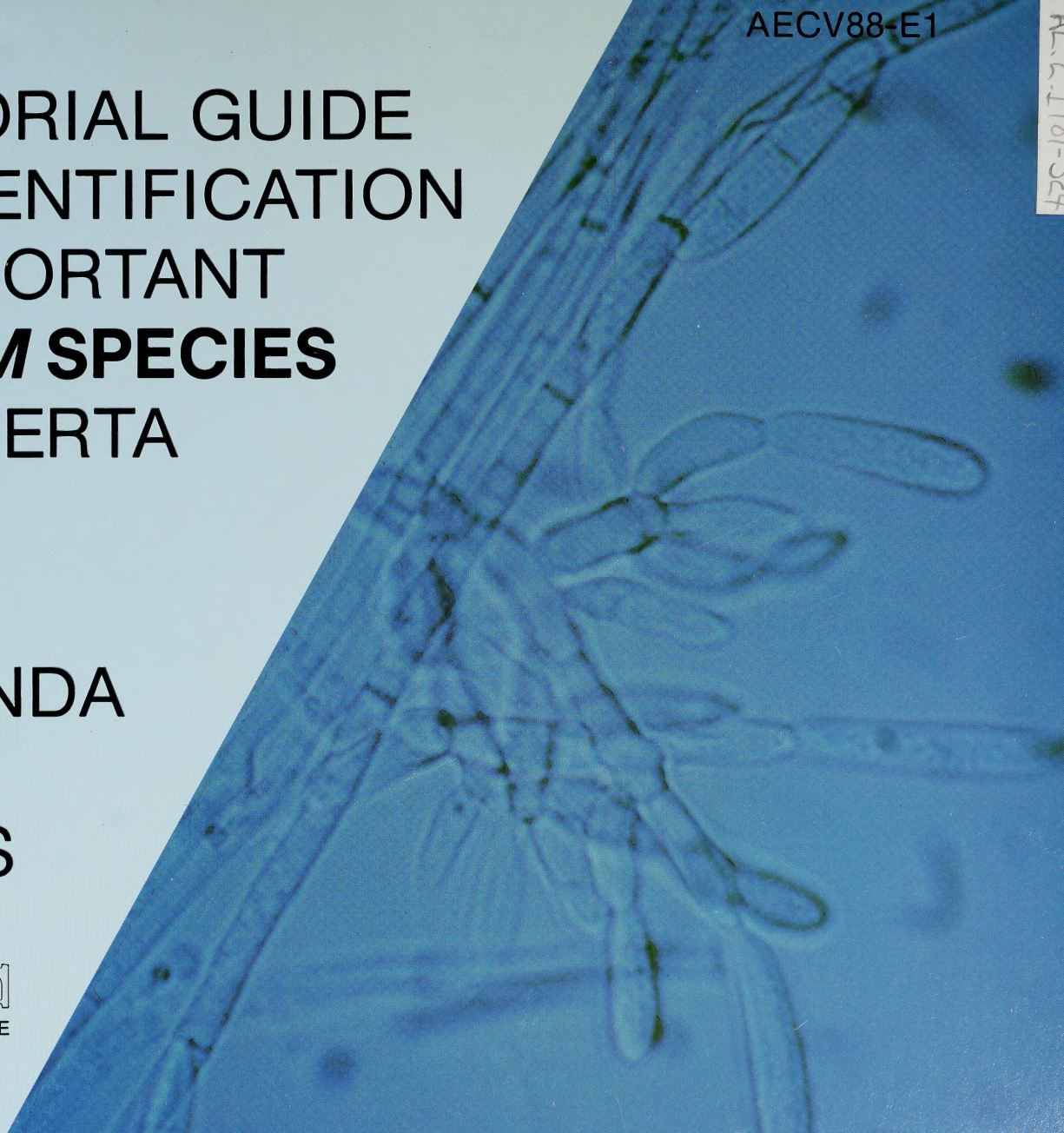
AND
STEVENS

Alberta
ENVIRONMENTAL CENTRE



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A PICTORIAL GUIDE TO THE IDENTIFICATION OF IMPORTANT FUSARIUM SPECIES IN ALBERTA

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Introduction

This guide was developed for the Fusarium Identification Workshop organized in conjuction with the 1986 annual meeting of the Plant Pathology Society of Alberta at the Alberta Environmental Centre in Vegreville. The classification system developed by Nelson et al. (1983) was followed. The guide was perceived to be quite simple for initial identification of Fusarium species, and the Workshop participants wished to obtain a set of these pictures for their personal use. As well, for the benefit of those who could not attend the Workshop, this manual was prepared to provide a starting point to the very complex task of Fusarium species identification.

This guide does not fully describe the Fusarium species, and not all characteristics of and variations within a species are mentioned; instead only the major features helpful in distinguishing species are presented. For complete description of species the reader should consult Nelson et al. (1983) or Gerlach and Nirenberg (1982).

The identification keys are based upon four major characteristics: occurrence and shape of microconidia; distinctive features of macroconidia; occurrence of chlamydospores; and mono- or polyphialide character of conidiophores. Secondary characteristics, such as color of mycelium, medium pigmentation, growth rate, and odor are not mentioned unless we found them quite helpful in our experience.

The Fusarium isolates used for the pictures were either obtained from Dr. P.E. Nelson, Fusarium Research Center, Pennsylvania State University, or collected in a survey of overwintered cereal grains in the Peace River Region of Alberta during 1984-85. Identification of some of the isolates from that survey was also confirmed by Dr. P.E. Nelson. The Guide will prove most useful for identifying Fusarium species prevalent in temperate regions, especially those associated with cereals.

Photo Credits

All photomicrographs in this publication were done by Rita Stevens, Plant Pathology Section, Alberta Environmental Centre.

Preparation of Fusarium Cultures

Isolates from the overwintered cereal grains were isolated on modified Nash - Snyder medium, and single spored on to potato dextrose agar (PDA).

The Nash - Snyder medium consists of: Difco peptone, 15g; agar, 20g; KH_2PO_4, 1g; $MgSO_4$ $7H_2O$, 0.5g; Pentachloronitrobenzene, 1g; streptomycin, 300 ppm; distilled H_2O, 1 L.

For identification, and for photographing microsopic features, all single spore isolates were cultured on carnation leaf agar (CLA) as described by Fisher et al. (1982). Young carnation leaves harvested from actively growing plants were cut into pieces approximately 5 mm X 5 mm, dried at 45°C for 2 hours, and sterilized with 2.5 megarads of gamma irradiation from a Cobalt 60 source. Several sterile leaf pieces were floated on 17% water agar cooled to 45°C in a petri dish, and the medium was allowed to set.

All Fusarium cultures were grown for 14 days at 23°C under supplemental fluorescent and NUV lights prior to use. Slides for microscopic observations were prepared in sterile distilled water, and younger parts of the cultures were used to examine the polyphialide character of conidiophores.

Using the Key

In the key, major contrasting characteristics used to reach the Sections are presented on one page for easier comparison. The main distinguishing characteristics of various species within a Section are then described on a separate page which is immediately followed by corresponding photomicrographs.

Users are urged to use the method described to prepare cultures for microsocpic observation. Stepwise observations will be helpful in following the key:

1. Observe the CLA plates without covers directly under low power (X 100, preferably X 200) to reveal presence or absence of microconidial chains, and to view the arrangement of microconidia and macroconidia on conidiophores.
2. Prepare culture mounts for microscopic observation in sterile distilled water. Observe the typical features of microconidia taken from aerial mycelium and/or macroconidia taken from sporodochia under low power (X 100); note that first impressions are most helpful in deciding overall characteristics of conidia.
3. Look for presence or absence of chlamydospores in the older parts of the culture.
4. Examine the poly- or monophialide character of conidiophores from younger parts of the culture under high power (x 400).
5. Examine culture in PDA tubes for the presence of microconidia especially for species in section sporotrichiella, and for the presence of chlamydospores.

Literature Cited

Fisher, N.L., L.W. Burgess, T.A. Toussoun, and P.E. Nelson. 1982. Carnation leaves as a substrate and for preserving cultures of Fusarium species. Phytopathology 72:151-153.

Gerlach, W., and H. Nirenberg. 1982. The genus Fusarium - a Pictorial Atlas. Mitt. Biol. Bundesanst. Land-Forstwirtsch. Berlin-Dahlem 209:1-406.

Nelson P.E., T.A. Toussoun, and W.F.O. Marasas. 1983. Fusarium species - An illustrated manual for identification. The Pennsylvania State University Press. University Park, PA. 193 pp.

Acknowledgements

We are grateful to Dr. P.E. Nelson, Pennsylvania State University, for reviewing this manual, providing typical cultures of several Fusarium species, and for confirming identification of several of our isolates. We also thank Dr. S-F. Hwang, Alberta Environmental Centre, for helpful suggestions on differentiating characteristics of some of the species.

Key to the Identification of Fusarium Species

A. Aerial mycelium not present.

Examine Carnation Leaf Agar (CLA) plate with the naked eye. If no aerial mycelium is present and colony is slimy, yeast-like, it belongs to Section Eupionnotes which includes species common in soil, polluted water or sludge, or is a mutant. Section Eupionnotes and mutants are not discussed further.

B. Aerial mycelium present.

Check mycelium on the CLA plate under low power (X100-200).

B.1 Microconidia abundant

	Section
B.1.a Microconidia in false heads; chlamydospores generally present.	
(i) Microconidia may be lemon, pear, sausage or spindle shaped. Microconidia often formed only on PDA.	SPOROTRICHIELLA (Page 6)
(ii) Microconidia oval or kidney shaped.	ELEGANS (Page 12) MARTIELLA (Page 12)
B.1.b Microconidia in chains and/or false heads; chlamydospores absent.	
(i) Very long macroconidia, generally with 9 septa, microconidia in chains on unbranched monophialide conidiophores.	SPICARIOIDES (Not discussed)
(ii) Absence of very long macroconidia.	LISEOLA (Page 16)

B.2 Microconidia usually absent or sparse.

B.2.a Macroconidia delicate; dorsal surface is markedly curved, foot cell is very distinct, and apical cell is drawn out.	
(i) Chlamydospores absent.	ROSEUM (Page 21)
(ii) Chlamydospores present.	GIBBOSUM (Page 24) ARTHROSPORIELLA (Page 29)
B.2.b Macroconidia robust and have thick walls and septa; chlamydospores are present.	DISCOLOR (Page 32) LATERITIUM (Page 39)

B.1.a(i)

SECTION SPOROTRICHIELLA

Fusarium poae

Fusarium tricinctum

Fusarium sporotrichioides

Fusarium chlamydosporum

Section SPOROTRICHIELLA

F. poae (Fig. 7.1-7.4)

- Abundant white aerial mycelium
- Microconidia on plate resemble bunches of grapes (low power)
- Microconidia oval or globose, often with distinct papilla
- Distinctive odor
- Monophialide conidiophores
- Chlamydospores infrequent

F. tricinctum (Fig. 8.1-8.4)

- Typical aerial microconidia on monophialide conidiophores (low power)
- Microconidia pear, lemon, spindle or sausage shaped
- Chlamydospores in chains

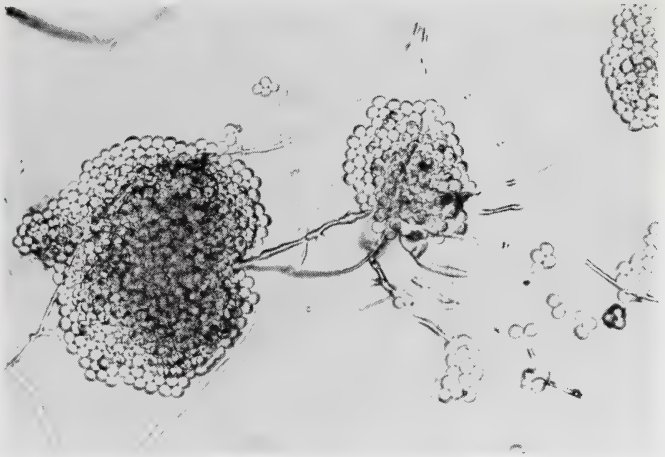
F. sporotrichioides (Fig. 9.1-9.4)

- Typical aerial macroconidia on polyphialide conidiophores (low power)
- Microconidia spindle or pear shaped
- Monophialide and polyphialide conidiophores
- Chlamydospores in chains and/or clumps

F. chlamydosporum (Fig. 10.1-10.4)

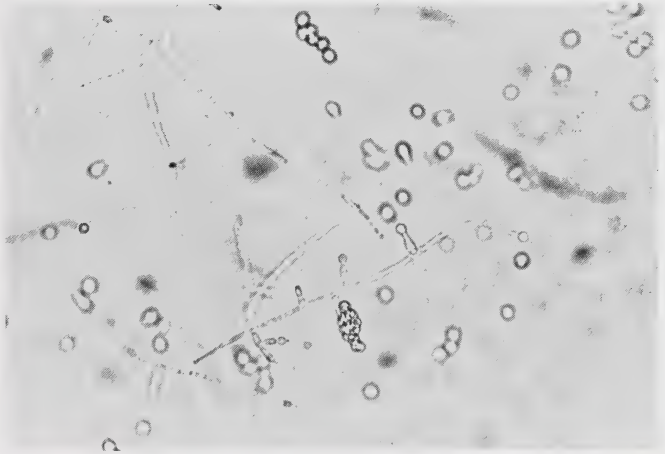
- Typical aerial microconidia on polyphialide conidiophores (low power)
- Only spindle shaped microconidia
- Monophialide and polyphialide conidiophores
- Abundant chlamydospores

Fusarium poae



7.1 MICROCONIDIA ON CLA PLATE (X200)

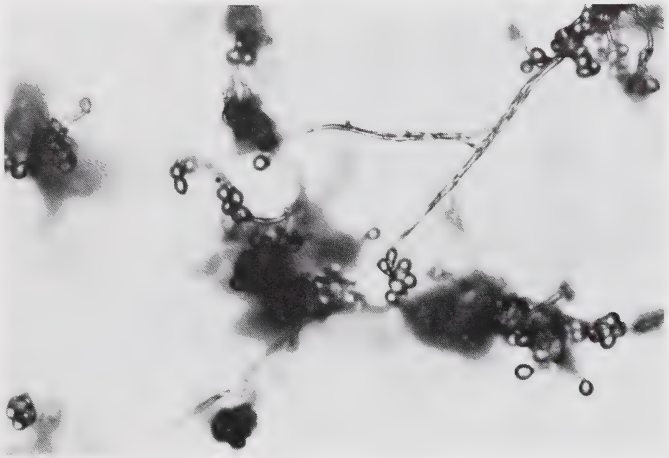
7.2 MICROCONIDIA AND MACROCONIDIA (X800)



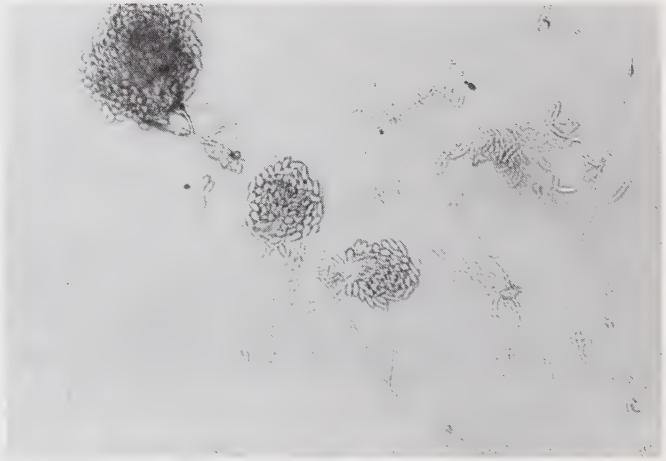
7.3 MONOPHIALIDE MICROCONIDIOPHORES (X200)

7.4 MONOPHIALIDE MICROCONIDIOPHORES (X800)

Fusarium tricinctum



8.1 MICROCONIDIA ON MONOPHIALIDE CONIDIOPHORES ON CLA PLATE (X200)



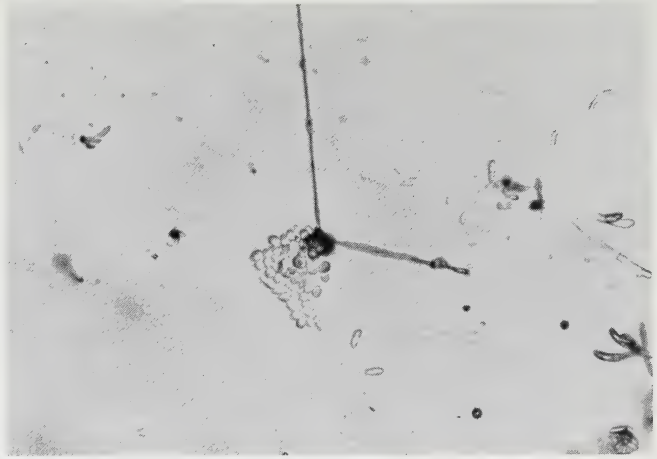
8.2 TWO TYPES OF MICROCONIDIA ON CLA PLATE (X200)

8.3 TWO TYPES OF MICROCONIDIA (X800)

8.4 MONOPHIALIDE MICROCONIDIOPHORES (X800)

Fusarium sporotrichioides

9.1 MACROCONIDIA ON POLYPHIALIDE CONIDIOPHORES IN AERIAL MYCELIUM ON CLA PLATE (X200)



9.2 TWO TYPES OF MICROCONIDIA ON CLA PLATE (X200)

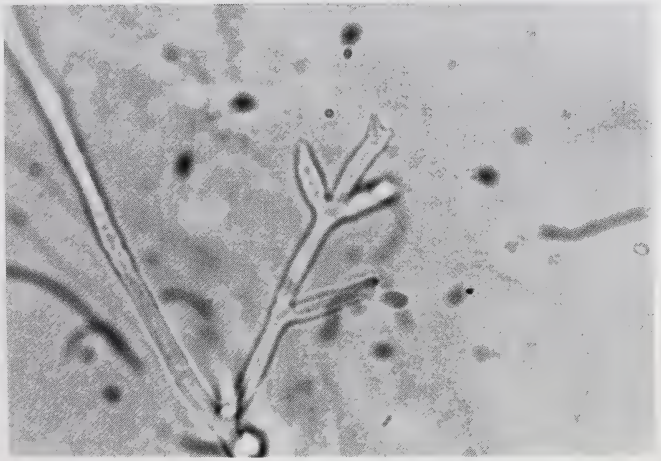
9.3 POLYPHIALIDE MICROCONIDIOPHORES (X800)

9.4 TWO TYPES OF MICROCONIDIA (X800)

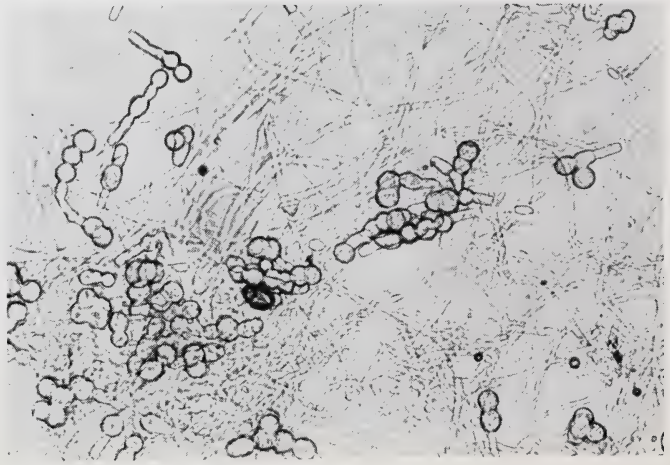
Fusarium chlamydosporum

10.1 MICROCONIDIA ON POLYPHIALIDE CONIDIOPHORES IN AERIAL MYCELIUM ON CLA PLATE (X200)

10.2 MICROCONIDIA (X800)



10.3 POLYPHIALIDE MICROCONIDIOPHORE (X800)



10.4 CHLAMYDOSPORES (X200)

B.1.a(ii)

SECTION ELEGANS	SECTION MARTIELLA
Fusarium oxysporum	Fusarium solani

Section ELEGANS

F. oxysporum (Fig. 13.1-13.4)

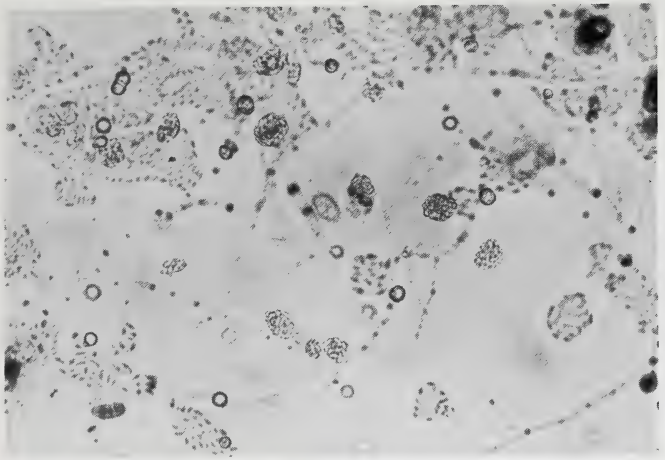
- Microconidia in false heads born on short monophialide conidiophores (low power)
- Macroconidia delicate looking, slightly sickle shaped
- Foot cell distinctly pedicellate
- Apical cell attenuated
- Purple sclerotia sometimes present

Section MARTIELLA

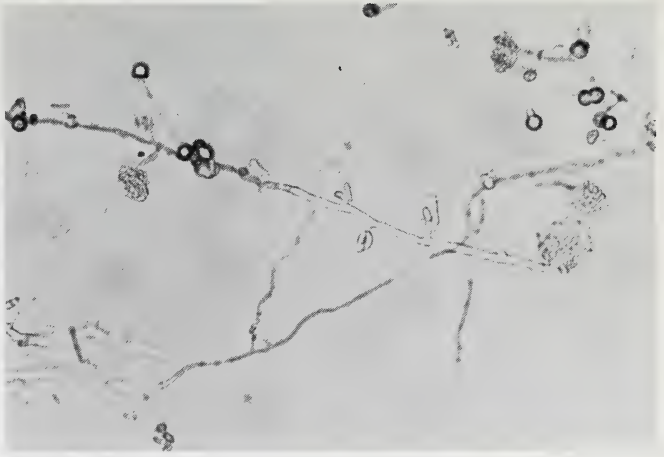
F. solani (Fig. 14.1-14.3)

- Microconidia in false heads born on long monophialide conidiophores, sparsely branched (low power)
- Macroconidia robust looking, generally cylindrical, with dorsal and ventral surface parallel for most of the length
- Foot cell mostly rounded
- Apical cell blunt and rounded
- Sporodochia cream, beige, tan, or occasionally blue to blue-green.

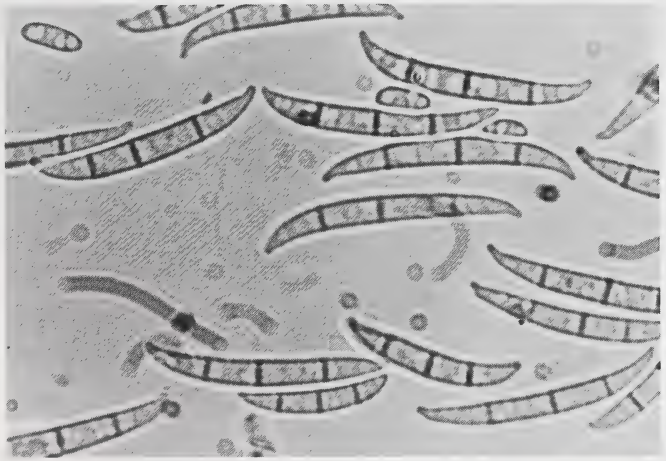
Fusarium oxysporum



13.1 MICROCONIDIA IN FALSE HEADS ON CLA PLATE (X200)



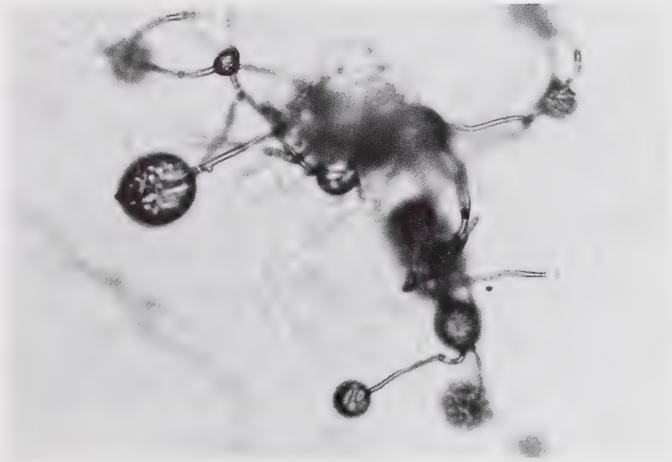
13.2 MICROCONIDIA ON CLA PLATE SHOWING SHORT MONOPHIALIDE MICROCONIDIOPHORES (X200)



13.3 MICRO AND MACROCONIDIA (X800)

13.4 BRANCHED AND UNBRANCHED MONOPHIALIDE CONIDIOPHORES (X800)

Fusarium solani



14.1 MICROCONIDIA IN FALSE HEADS ON LONG MONOPHIALIDE MICROCONIDIOPHORES ON CLA PLATE (X200)

14.2 MACRO AND MICROCONIDIA (X800)

14.3 LONG MONOPHIALIDE MICROCONIDIOPHORES (X200)

B.1.b(ii)

SECTION LISEOLA

Fusarium moniliforme

Fusarium proliferatum

Fusarium subglutinans

Section LISEOLA

F. moniliforme (Fig. 17.1-17.3)

- Chains of microconidia on branched and unbranched monophialide conidiophores (low power)
- Microconidia oval to club shaped, with flattened base
- Macroconidia only slightly sickle shaped when present with thin, delicate walls

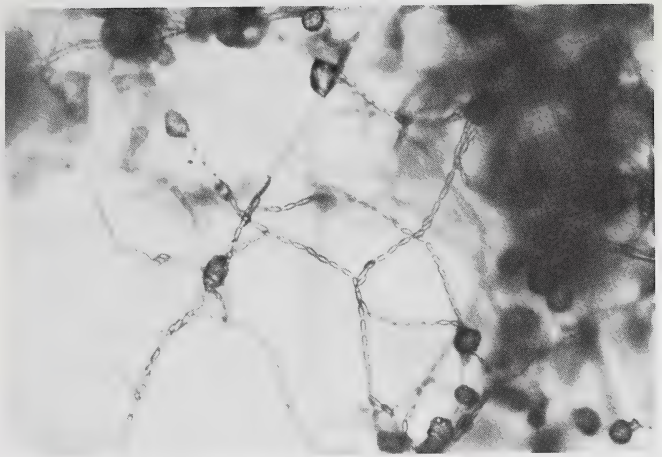
F. proliferatum (Fig. 18.1-18.4)

- Chains of microconidia on polyphialide conidiophores (low power)
- Microconidia oval to club shaped with flattened base
- Macroconidia abundant, only slightly sickle shaped with thin, delicate walls

F. subglutinans (Fig. 19.1-19.4)

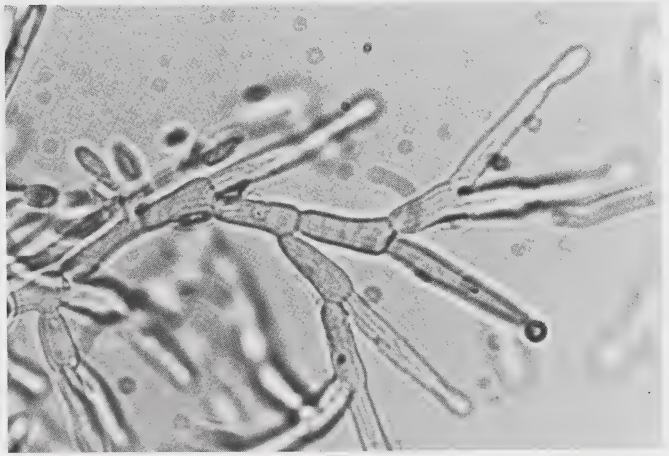
- Typical aerial microconidia on polyphialide conidiophores; look like rabbit ears (low power)
- Microconidia oval, one-celled to 1-3 septate
- Macroconidia abundant, only slightly sickle shaped with thin delicate walls

Fusarium moniliforme



17.1 MICROCONIDIA IN CHAINS AND FALSE HEADS ON CLA PLATE (X200)

17.2 MICROCONIDIA (X800)



17.3 MONOPHIALIDE CONIDIOPHORE (X800)

Fusarium proliferatum

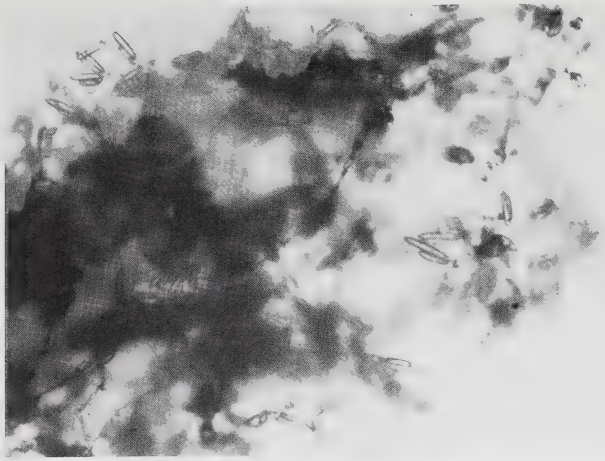
18.1 CHAINS OF MICROCONIDIA ON POLYPHIALIDE MICROCONIDIOPHORES ON CLA PLATE (X200)

18.2 MICROCONIDIA (X800)

18.3 POLYPHIALIDE MICROCONIDIOPHORE (X800)

18.4 MONOPHIALIDE CONIDIOPHORE (X800)

Fusarium subglutinans



19.1 MICROCONIDIA ON POLYPHIALIDE MICROCONIDIOPHORES IN AERIAL MYCELIUM ON CLA PLATE (X200)

19.2 MICROCONIDIA (X800)

19.3 MACROCONIDIA (X800)

19.4 POLYPHIALIDE MICROCONIDIOPHORES (X800)

B.2.a(i)

SECTION ROSEUM

Fusarium avenaceum

Fusarium graminum

Section ROSEUM

F. avenaceum (Fig. 22.1-22.3)

- Macroconidia are generally 5-septate, thin, needle like
- Microconidia are generally scarce, except in *F. arthrosporioides* which has oval 0- to 3-septate microconidia as well as typical macroconidia

F. graminum (no photomicrograph)

- Macroconidia are generally 3-septate, thin, needle like
- Microconidia are absent
- Monophialide conidiophores

Fusarium avenaceum

22.1 MACROCONIDIA ON CLA PLATE (X200)

22.2 MACROCONIDIA (X800)

22.3 MONOPHIALIDE CONIDIOPHORES (X200)

B.2.a(ii)

SECTION GIBBOSUM

Fusarium equiseti

Fusarium compactum

Fusarium acuminatum

Fusarium scirpi

Fusarium longipes

Section GIBBOSUM

F. equiseti (Fig. 25.1-25.4)

- Most typical macroconidia of the Section Gibbosum; sickle shaped, with distinctive curve and dorsal hump
- Basal cell distinctly foot shaped, often exaggerated
- Monophialide conidiophores
- Chlamydospores abundant in some strains

F. compactum (Fig. 26.1-26.3)

- Macroconidia resemble those of F. equiseti but shorter, fatter, broader in the middle, and look more compact
- Basal cell distinctly foot shaped, often exaggerated
- Monophialide conidiophores
- Chlamydospores abundant in some strains

F. acuminatum (Fig. 27.1-27.3)

- Macroconidia are needle like, delicate as in F. avenaceum and without dorsal hump that is present in F. equiseti
- Basal cell foot shaped
- Monophialide conidiophores
- Chlamydospores may develop slowly in some cultures, and could take several weeks

F. scirpi (no photomicrograph)

- Macroconidia resemble those of F. equiseti but apical cell is more drawn out
- Basal cell distinctly foot shaped, often exaggerated
- Monophialide and polyphialide conidiophores with typical aerial microconidia which look like rabbit ears (low power)
- Chlamydospores present

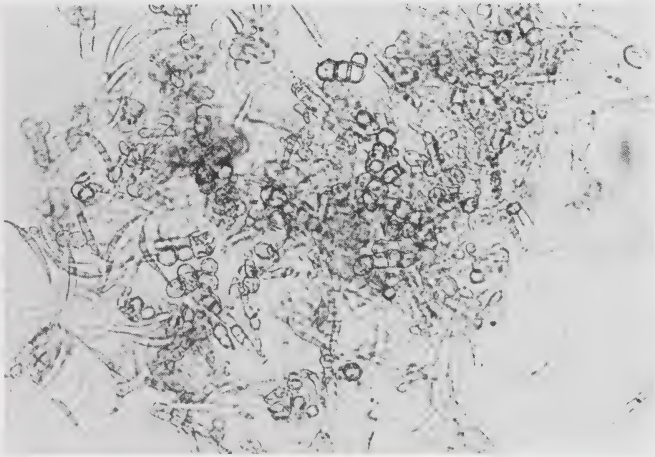
F. longipes (no photomicrograph)

- Macroconidia are very distinctive with a whip like apical cell, and extended foot shaped basal cell
- Monophialide conidiophores
- Chlamydospores present

Fusarium equiseti

25.1 MACROCONIDIA (X800)

25.2 MICROCONIDIA (X800)

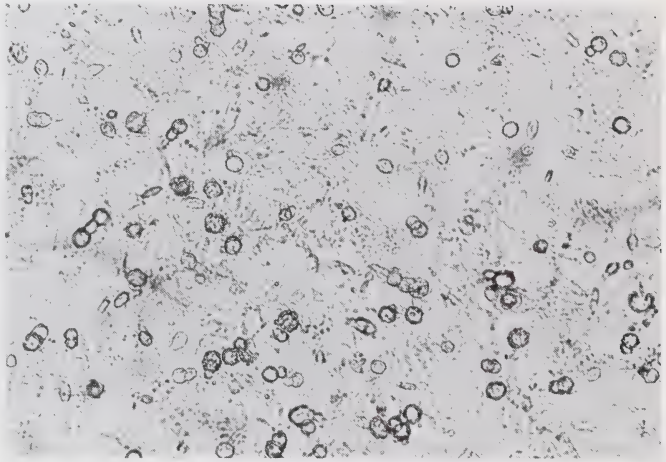


25.3 CHLAMYDOSPORES (X200)

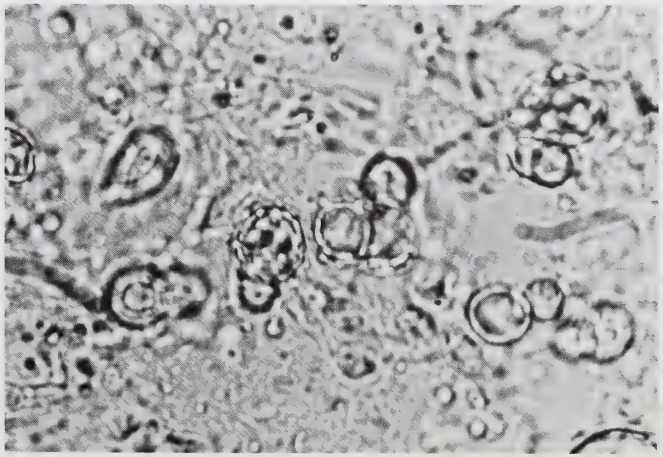
25.4 CHLAMYDOSPORES AND MONOPHIALIDE CONIDIOPHORES (X800)

Fusarium compactum

26.1 MACROCONIDIA (X800)

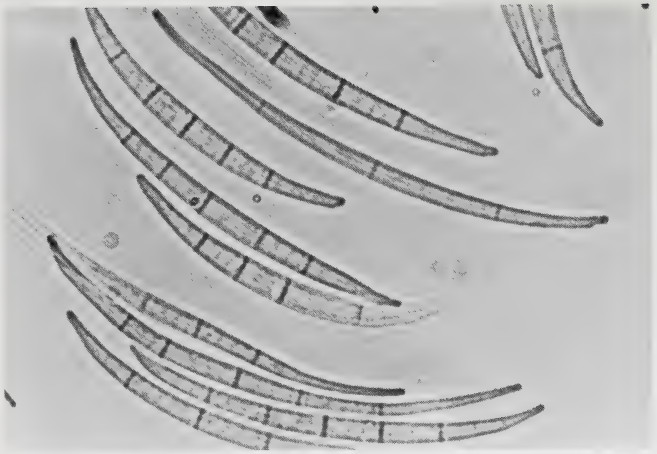


26.2 CHLAMYDOSPHORES ON CLA PLATES (X200)

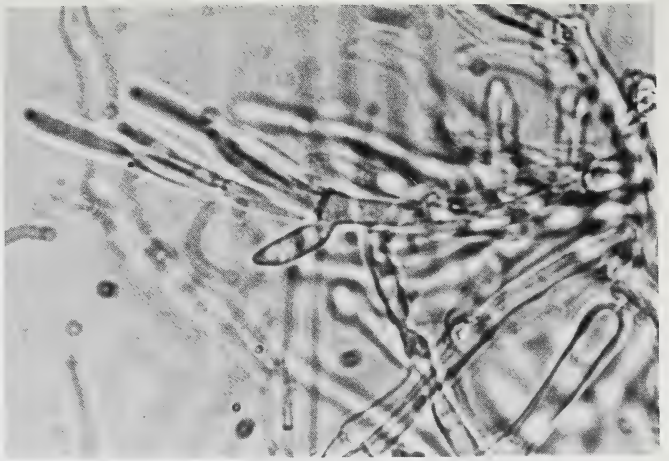


26.3 CHLAMYDOSPORES (X800)

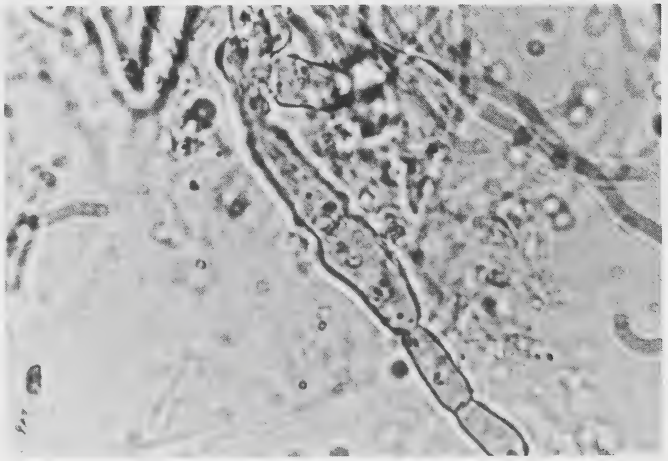
Fusarium acuminatum



27.1 MACROCONIDIA (X800)



27.2 MONOPHIALIDE CONDIOPHORES (X800)



27.3 CHLAMYDOSPORES (X800)

B.2.a(ii)

SECTION ARTHROSPORIELLA

Fusarium semitectum

Section ARTHROSPORIELLA

F. semitectum (Fig. 30.1-30.4)

- Very distinctive spindle shaped macroconidia produced on polyphialides in the aerial mycelium

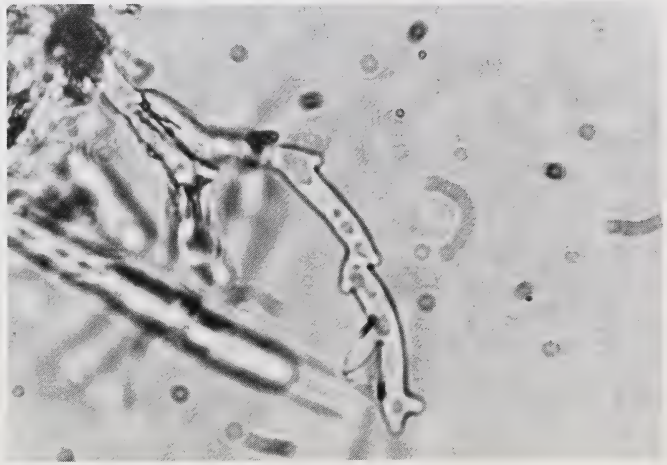
- Curved macroconidia produced in sporodochia

Fusarium semitectum

30.1 SPINDLE SHAPED MACROCONIDIA ON POLYPHIALIDE CONIDIOPHORES IN AERIAL MYCELIUM ON CLA (X200)

30.2 CURVED MACROCONIDIA FROM SPORODOCHIA (X800)

30.3 SPINDLE SHAPED MACROCONIDIA FROM AERIAL MYCELIUM (X800)



30.4 POLYPHIALIDE CONIDIOPHORES (X800)

B.2.b

SECTION DISCOLOR

Fusarium culmorum

Fusarium sambucinum

Fusarium crookwellense

Fusarium graminearum

Fusarium reticulatum

Section DISCOLOR

F. culmorum (Fig. 33.1-33.3)

- Macroconidia are broad, fat, and short
- Apical cell is not notched
- Foot cell is notched or pedicellate
- Monophialide conidiophores

F. sambucinum (Fig. 34.1-34.3)

- Macroconidia are narrower than *F. culmorum* at mid-width
- Apical cell is notched, not distinguishable from foot cell
- Foot cell is more pronounced than in *F. culmorum*
- Monophialide conidiophores
- Slower growing than *F. culmorum*

F. crookwellense (Fig. 35.1-35.3)

- Macroconidia are narrower than in *F. culmorum*; slightly curved; dorsal surface is more curved than ventral surface
- Apical cell is not notched but beaked and can be easily distinguished from foot cell
- Foot cell is more pronounced than in *F. sambucinum*
- Monophialide conidiophores
- Culture may look like *F. culmorum* but macroconidia are different

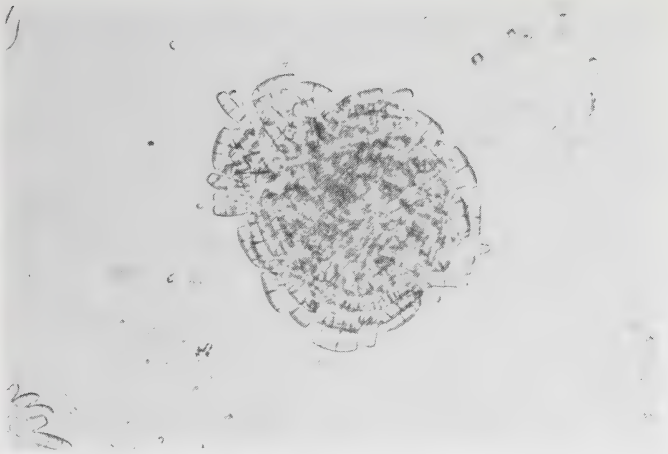
F. graminearum (Fig. 36.1-36.4)

- Macroconidia are similar to *F. crookwellense* but are more straight and narrower (like an old viking ship)
- Monophialide conidiophores
- Some isolates form perithecia

F. reticulatum (Fig. 37.1-37.3)

- Macroconidia are sickle shaped, narrow at both ends, generally 3-septate.
- Most slender macroconidia in the Section Discolor
- Monophialide conidiophores

Fusarium culmorum



33.1 MACROCONIDIA ON CLA PLATE (X200)

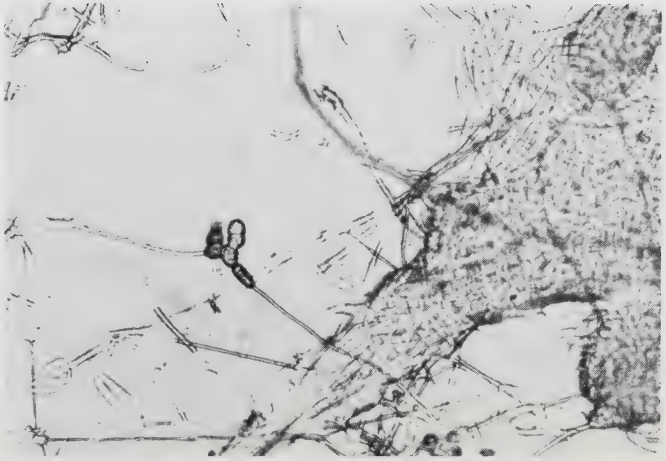
33.2 MACROCONIDIA (X800)

33.3 MONOPHIALIDE CONIDIOPHORES (X800)

Fusarium sambucinum

34.1 MACROCONIDIA (X800)

34.2 MONOPHIALIDE CONIDIOPHORES (X800)

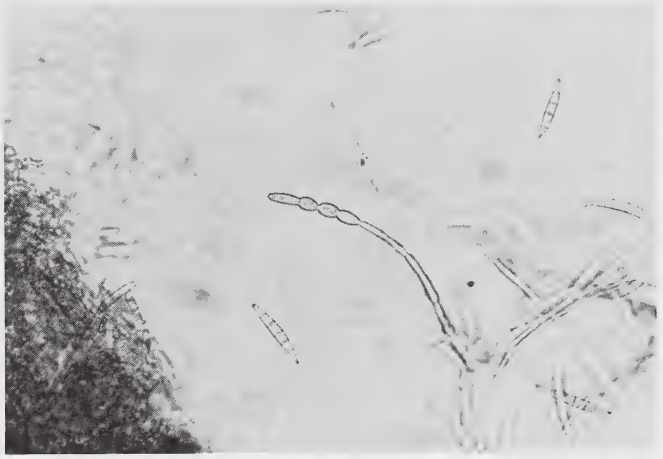


34.3 CHLAMYDOSPORES ON CLA PLATES (X200)

Fusarium crookwellense

35.1 MACROCONIDIA (X800)

35.2 MONOPHIALIDE CONIDIOPHORES (X800)

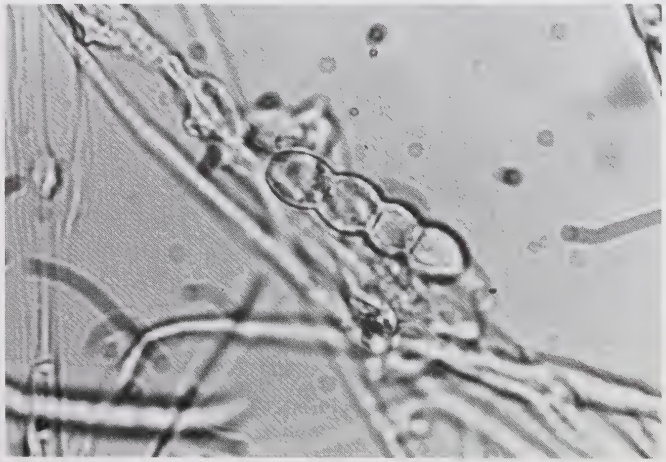


35.3 CHLAMYDOSPORES (X200)

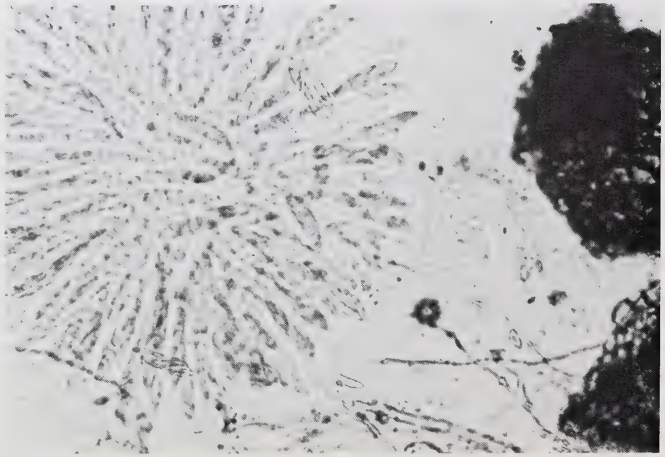
Fusarium graminearum

36.1 MACROCONIDIA (X800)

36.2 MONOPHIALIDE CONIDIOPHORES (X200)



36.3 CHLAMYDOSPORES (X800)

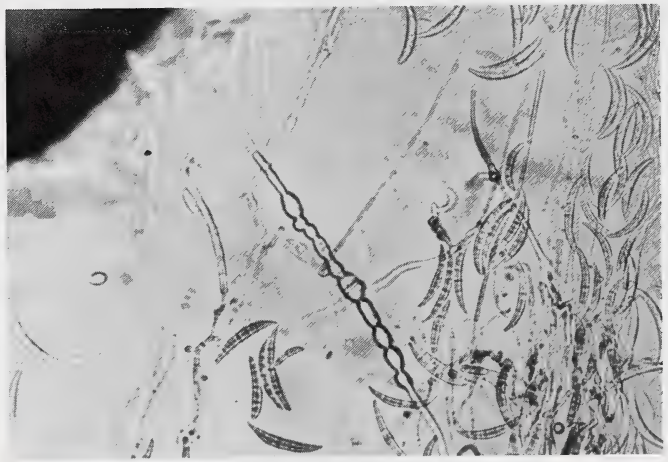


36.4 PERITHECIUM AND ASCI (X200)

Fusarium reticulatum

37.1 MACROCONIDIA (X800)

37.2 MONOPHIALIDE CONIDIOPHORES (X800)



37.3 CHLAMYDOSPORES ON CLA PLATE (X200)

B.2.b

SECTION LATERITIUM

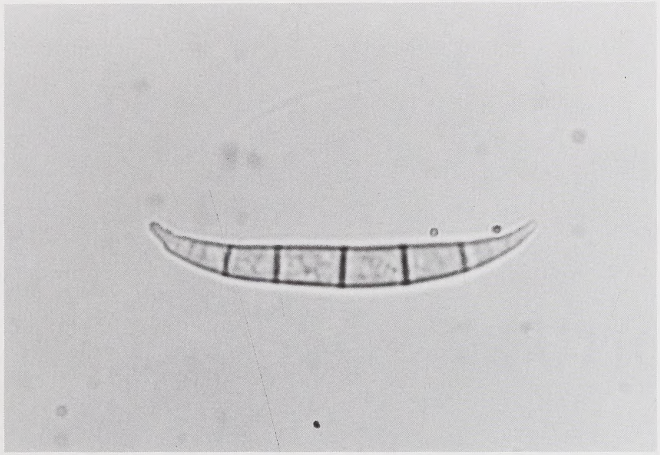
Fusarium lateritium

Section LATERITIUM

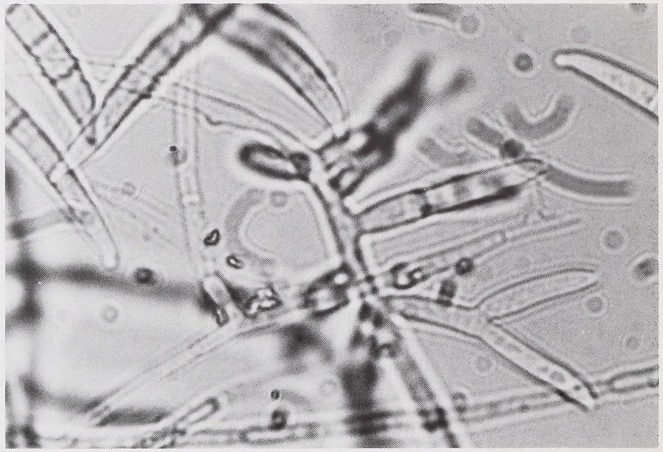
F. lateritium (Fig. 40.1-40.3)

- Macronconidia may look like those of *F. graminearum*, except that apical cell is distinctively beaked or hooked
- Some clones produce abundant spindle to club shaped microconidia, 0-3 septate
- Monophialide conidiophores
- Chlamydospores sparse, mostly single or in pairs
- Slow growing with sparse aerial mycelium.

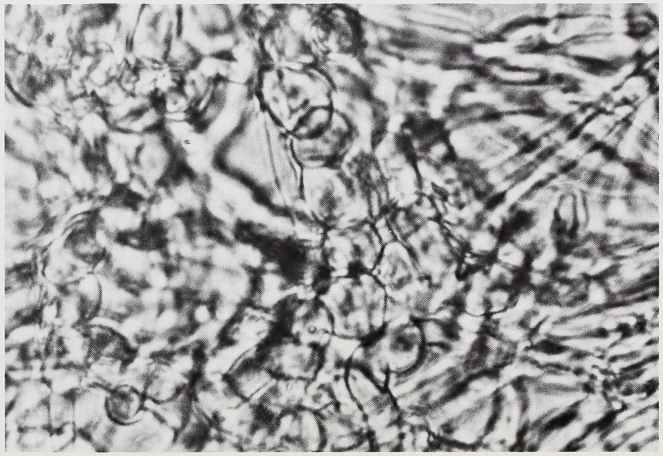
Fusarium lateritium



40.1 MACROCONIDIA (X800)



40.2 MONOPHIALIDE CONIDIOPHORES (X800)



40.3 CHLAMYDOSPORES (X800)

N.L.C. - B.N.C.
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